

Safety HandBook

2024-2025 (revised 22.08.24)

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This Safety Handbook carries only a brief summary of the Department of Chemistry Safety Rules. More detailed information and reference data can be found in the Safety Manual on the Internet at <https://chemistry.nus.edu.sg/health-safety/more-safety-information/>

Emergency Telephone Numbers

CAMPUS SECURITY	6874-1616 (24 h)
	6516-2365 (Bioscience only)
Department Safety Officer	6516-1760
Nearest Hospital (NUH)	6772-5000
Fire/Ambulance	995
Police	999

Basic First Aid

**If anyone becomes unconscious following an injury,
call 6874 1616 (security) if after office hours**

Cuts

Control the bleeding by applying pressure over the wound with a pad of paper tissue or towel roll. Do not attempt to remove any broken glass etc. Seek medical attention.

Avoid contact with blood

Burns

Douse the burn with copious amounts of cold water e.g. under a running tap. Do not attempt to remove anything sticking to the burn. Seek medical attention.

Chemicals

On Skin: Wash off with copious amounts of water. Seek medical attention if necessary.

In Eyes: If available use an eye-wash spray with the eyelids held open. Otherwise use a cold running tap. Seek medical attention if necessary.

Inhaled: If possible, move to fresh air. Seek medical attention.

Swallowed: Seek medical attention. Identify the chemical.

Electricity
Switch off power. Call 6874 1616 for help.

Other injuries - falls, blows
Call for medical attention.

First Aiders

In the event of a serious injury, use the emergency number 6874 1616 which accesses University Security on a 24 hour line.

For minor injuries, First Aiders may be called.

Wong Suk Tak, Carrie
Wong Ling Rong

65166361
66016973

Admin Office, S8-03
Advance Chemistry Teaching lab, S7-04

IN CASE OF SEVERE ACCIDENT, RING 6874 1616 FIRST.

First Aid Boxes

First Aid Boxes should be kept stocked according to the list posted on the front or within the box. If the plastic lock is broken, the items taken need to be replaced.

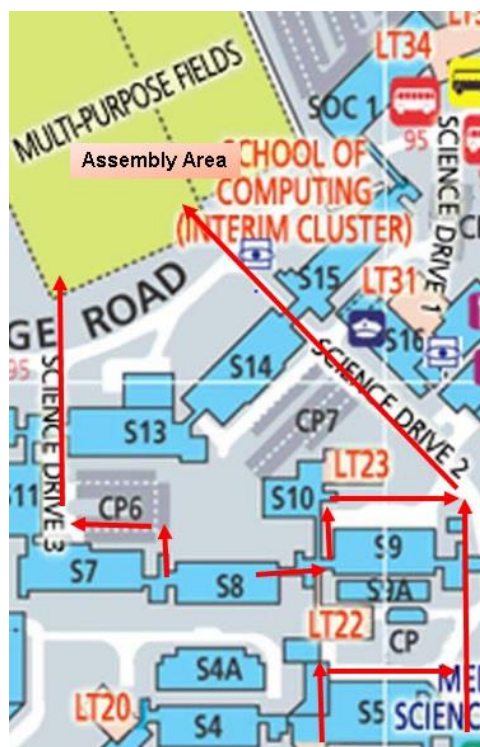
All First Aid material is available from the Safety Officer and Staff in charge of laboratories should nominate a member of that laboratory to see that the stock of the First Aid box is regularly maintained.

Emergency (Fire) Alarms

The buildings in the Chemistry Department are equipped with a fire detection system that will sound the alarms if a sensor detects flame, heat or smoke or if the break-glass alarm button is activated.

In the event of an alarm, spend a few seconds only in turning off heating equipment or making your experiment safe before leaving the building by the route that has been described to you. Do not use the lifts. Assemble at the designated area for a roll-call.

Do not attempt to enter the building until you have been told it is safe to do so.



Coping with an Emergency

Normal Working Hours: These are from 8:30 a.m. to 6:00 p.m. Monday to Thursday and 8:30 am to 5:30 pm on Friday.

Precautions

Know at least *two* routes from your workplace to an Exit.

Know the locations of: Telephones, Fire Extinguishers and Blankets, Fire Alarm Points, Safety Showers, Eye Wash Stations and First Aid Boxes.

Know how to contact Campus Security.

Know how to switch off electricity, gas, water etc. in and around *your* workplace.

Evacuation Procedure

All tests sounding of the alarms will be notified in advance. **In the event of an evacuation, follow the route given in the Dept of Chemistry Emergency Evacuation Route map. Never use a lift.** Assemble away from danger and clear of the building. Do not re-enter the building until you are told that it is safe to do so.

Fire

If the fire is clearly minor, tackle it with an extinguisher **but do not endanger yourself**. Normally the sensors will detect any fire and the Alarm will operate automatically. Otherwise, operate the nearest Alarm Point and call Campus Security at 6874 1616

Escape of Toxic Material

Leave the area immediately. Close all doors on exit. **Operate the nearest Fire Alarm Point.** Warn people to avoid the affected area and inform Campus Security at 6874 1616.

Aiding an Injured

Either phone for a First Aider or if more serious call Campus Security

Person	at 6874 1616 first, then a First Aider. Even if the Alarms sound, do not attempt to move the injured person out of the building unless there is imminent danger. Stay with the injured person until help arrives. If the injury is slight they should be taken by taxi with a First Aider in attendance or, if the injury is more serious, by Ambulance.
Flood	If it is obvious, stop the leak; phone Campus Security at 6874 1616 for urgent situations. Warn people in labs below to safeguard papers and equipment. Do not attempt to move wet electrical equipment until it is disconnected from the mains.
Failure of Mains Service	Failure of fume-hood, gas, water, electricity or lifts, call Maintenance Response Centre at 66017878 (24/7 hotline for essential services).

Health and Safety Procedures in the Department of Chemistry

The Internet-based "Safety Manual" may be found at <https://chemistry.nus.edu.sg/health-safety/more-safety-information/safety/>

If your time is to be spent in Office or Computing work solely, the information that you need to absorb will not be great, but for those working in workshops and laboratories, there is much more, in keeping with the greater potential hazards in those areas, hence it is important that you spend some time to read the Safety Manual.

The list of people involved with Health and Safety in the Department of Chemistry can be found on Page 18 of this Handbook or in the Safety website at:

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/personnel-connected-with-safety-in-the-department/>

A statement of Health and Safety Responsibilities, including yours, can be found at:

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/safety-health-and-environmental-policy/>

Risk Assessments

Risk Assessments are procedures to estimate the risks to Health and Safety associated with any work activities you perform and to devise rules and methods of work to minimise these risks. The Workplace Safety & Health Act requires that Risk Assessments be carried out for all work that you do and that you are informed of the outcome of the assessment and are trained to carry out your duties safely. The Risk Assessment procedure applies to all kinds of work activities from the use of computer equipment to the manual handling of heavy items.

If you are not working in a Laboratory or Workshop

If your workplace is not a laboratory or workshop, e.g. if you are a member of the Secretarial staff or a researcher carrying out a project which is purely computational, then the only Risk Assessments you need to read are those concerning **General Office Work**, **Visual Display Equipment** and **Standard Electrical Equipment**. You can access these from the list at:

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/prepared-risk-assessment-for-equipment-and-procedures/general-office-work/>

If you are working in a Laboratory

Risk Assessments: If you are carrying out research work, your Supervisor should supply you with a copy of your **Project Risk Assessment**. This will give you some guidance as to the individual Prepared Risk Assessments relevant to your Research Project which you must read and then undergo any necessary training. The full list can be found at:

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/prepared-risk-assessment-for-chemicals-and-materials/> and

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/prepared-risk-assessment-for-equipment-and-procedures/>

You must also do a risk assessment of each experiment using the by Office of Risk Management and Compliance (ORMC) activity-based Excel file. (See Forms you must Complete below.)

Forms you must Complete

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/health-and-safety-procedures-in-the-department-of-chemistry/risk-assessment/risk-assessment-forms/>

- Once you have read the appropriate Prepared Risk Assessments, then you should complete the **Risk Assessment Record Form for Graduates and Research Workers** remembering to indicate your status (Undergraduate, Graduate, etc.) and giving a brief description of your Research project.
- A **step-by-step activity-based risk assessment** must be carried out before you start on any each experiment. Use the Excel file risk assessment by ORMC. <https://chemistry.nus.edu.sg/wp-content/uploads/sites/3/2023/07/Activity-based-risk-assessment.xls>
- Sign the forms and have them signed by your Supervisor.
- Keep the hardcopies in your laboratory.

You must renew the form if the nature of your research project changes substantially.

When you have finished research work, you are required to clear any chemicals, samples, equipment etc that you may have used. A form to indicate that you have done so is available and further information can be obtained at the website.

Preventing Fires and Floods

A laboratory door signage must be clearly posted outside each lab. The form gives details on the person(s) to contact in case of emergency and the type of hazards to be expected in the lab. The form can be downloaded from <https://www.nus.edu.sg/osh/labsign/default.aspx>.

Fire: Apart from the obvious dangers of horrendous injury and even death, fires are enormously destructive. **Remember, after a fire, you may have lost all of your work and your equipment will be gone.**

The Fire Detection System: All parts of the Department of Chemistry are fitted with fire detectors that are on alert at all times. A red light appears when a detector is activated, the alarms sound and you must leave the building until the alarm is over.

Take great care to avoid causing “false” alarms. However if you think that something you have done has caused the alarm, inform Campus Security at 6874 1616 immediately.

Solvents in Laboratories: You should store only a working minimum of flammable solvents in your laboratory since, in the event of fire; excess amounts of solvent could endanger life and the fabric of the building. **In any case, under the Fire Safety Regulations (2005), the maximum quantity of flammable liquids (L) stored in any one laboratory or workshop is based on 1.6 x floor area of the lab in m².** As far as possible, and certainly overnight, solvents should be stored in the ventilated safety cabinet provided for the purpose.

Leaving a Laboratory or Workshop: When you leave your workplace in the evening or during the day if you are to be away for long, you have the responsibility to check that:

- there are no obvious problems with reactions or equipment left running (these should be properly labelled).
- unnecessary electrical equipment, e.g. ovens, are turned off and **no naked flame or flammable gas is left on;**
- flammable solvents are properly stored in closed storage cupboards;
- fume-hoods are closed;
- lights are turned off;
- fire doors and other doors are closed.

Floods: Apart from the damage they can cause to equipment and paperwork and the considerable inconvenience to victims, floods can be dangerous, for example, by bringing down ceiling boards and wetting live electrical equipment. The greatest care must be taken to avoid floods.

Water Cooling Connections. Plastic tubing carrying cooling water to rotary evaporators, diffusion pumps or any other semi-permanent or temporary systems **must be fastened on to the apparatus and the water taps with wire, plastic tags or screw clips.** The exit tube must pass the water properly down a drain which is able to cope with the flow and be anchored to prevent splashing or ejection if the water pressure rises.

Personal Safety

General principles-

- Think before you start a piece of work.
- Never work alone.
- Wear the proper protective equipment.
- Keep your workplace tidy

Eating, Drinking or Smoking

Eating or drinking is forbidden in laboratories and workshops and smoking is forbidden in all parts of the Building. Eating or drinking is only permitted in designated student areas where there is no contact with chemicals.

Protective Clothing

Safety Glasses

Safety Glasses are available from Lab Supplies – payable from your supervisor's grant. Safety Glasses must be worn in all designated areas and whenever you are handling chemicals, glass vacuum or pressure apparatus and equipment with moving parts.

Contact Lenses: There is an ongoing debate as to whether it is safe to

wear contact lenses in a Chemistry Laboratory. The most important advice remains: **wear Safety Glasses**.

- Laboratory Coats** Wearing a lab-coat can give considerable protection against splashed chemicals and flash burns. Lab-coats must be worn in areas where wet chemistry is carried out. **This is the case in all synthetic chemistry laboratories.**
- Protective Gloves** Disposable gloves give short-term protection against some chemicals but some solvents may attack them. Many grades of gloves can be obtained which offer more, or less protection. Even if you have been wearing gloves, wash your hands frequently when working.
Never wear rubber or plastic gloves when working with a naked flame. Never wear gloves outside the lab. Gloves should not be worn for handling computer terminals, any equipment or door knobs.
- Shoes** Shoes which **fully** cover the feet and toes and not slip-ons should always be worn in a lab to protect against chemicals and glass cuts. Sandals, flip-flops, clogs, backless shoes, cloth shoes, open-toed shoes, high heeled shoes and stiletto-heeled shoes are **strictly** not allowed. In the laboratory, wear shoes with uppers made of leather or polymeric leather substitute.
- Personal Attire** Clothing must offer good protection against chemical spills and splashes. Tank tops, off-shoulder tops, halter-necks and shorts are not allowed. Legs and waists must be covered by your clothing. Excessively loose and flowing clothing should not be worn to labs.

Fume-hood Safety

Fume-hoods in the Department of Chemistry are of the built-in ducted type that vent to the outside through outlets on the roof. The sashes should be kept down as far as possible for maximum efficiency in coping with the removal of vapours.

Chemical Safety

It is mandatory under the Workplace Safety & Health Act to make a Risk Assessment of your work before you commence. These include an assessment of the health risks to you in handling chemicals **before the materials are used**. There are several legislations in Singapore relating to the use and storage of chemicals. Please refer to NUS Safety, Security and Sustainability website at https://inetapps.nus.edu.sg/osh/portal/chem_safety/chemsafety.html and inform yourself on the relevant chemicals.

The following points are worth emphasising:

- Common Solvents** Many common solvents, e.g., CH_2Cl_2 , are toxic and in handling (or spilling them) in the open laboratory you may exceed danger limits for the vapour concentration. Use a fume-hood whenever possible. Dusty substances can be as dangerous as highly volatile substances both in toxicity and in explosion risks.
- Spills** Absorbent materials to mop up spilled solvent are available in the laboratories. **If you are using large amounts of acid or base or any amount of strongly smelling material you must keep a neutralising agent at hand.**
- Carcinogenic Materials** **Category 1** - substances known to be carcinogenic to humans. There is sufficient evidence to establish a causal association between human exposure to the substance and the development of cancer. **Category 2** - substances that should be regarded as if they are carcinogenic to

humans, for which there is sufficient evidence, based on long-term animal studies and other relevant information, to provide a strong presumption that human exposure may result in the development of cancer. **Category 3** - substances that cause concern owing to possible carcinogenic effects but for which available information is not adequate to make satisfactory assessments.

Categories 1 and 2, if purchased from a supplier will carry the "toxic" (T) symbol and the [Risk Phrase](#) R45 (**May cause cancer**) or R49 (**May cause cancer by inhalation**). **Category 3**, if purchased from a supplier carries the "harmful" (Xn) symbol and the [Risk Phrase](#) R40 (**Limited evidence of a carcinogenic effect**).

Cyanides Great care must be taken when working with cyanides. The use of cyanides outside of normal working hours is forbidden.

Hydrofluoric acid **Great care must be taken when working with HF. The use of HF outside of normal working hours is forbidden.** At concentrations above 1M (2%) in water, HF can cause very painful burns that may not be apparent for some hours. Always wear gloves, a lab-coat and safety glasses when using this acid. Have available a tube of "**HF Antidote Gel/Calcium Gluconate**" (can be purchased from Beacon Pharmaceuticals) which should be applied if HF contacts the skin.

Electrical Safety

Notice the danger signs

On all electrical equipment you use, watch for signs of wear on the cable and insulation problems where it connects to the plug or equipment. Replace or rectify as necessary.

Plugs and Fuses

If you put a mains plug on a piece of equipment, follow the wiring colour code:

BROWN	LIVE
BLUE	NEUTRAL
GREEN-YELLOW	EARTH

Use the correct fuse for the equipment.

Water and electricity Wet electrical equipment is very dangerous. Disconnect from the mains before touching it. **Beware of wet heating mantles.**

Safety Testing

All portable electrical equipment (i.e. ,equipment that can be unplugged) must be tested regularly.
New, second-hand and old equipment must be tested before being brought into use.
Equipment that carries a "Failed" sticker must never be used.

Mechanical Safety

Carrying solvents Winchester bottles of solvents may be carried in the corridors or lifts only in carriers (maximum load per person, two carriers) or on appropriate trolleys

Rotary equipment Equipment with rotating parts, e.g. stirrers, rotary evaporators, rotary pumps must not be allowed to catch hair or clothing or any trailing wires or tubing.

Gas cylinders Large cylinders of compressed gases must be moved only in proper trolleys (which are designed to be pushed, not pulled) and transferred carefully to positions where they can be securely strapped. Only cylinder in use can be in the lab.
There are a number of types of regulators in use with different pressure scales: mark on your regulators the maximum safe pressure for routine work in your laboratory.

Never attempt to fit compressed gas cylinders if in doubt.

Glassware Safety

Evacuated glassware

When glassware under vacuum breaks, the implosion may spray glass pieces around. Hence, any glass Dewar vessels or evacuated flasks must be covered with strong sticky tape, plastic netting or be metal shrouded.

Glassware under pressure is even more dangerous and should only be used with total containment.

Broken glass and empty bottles

Broken glass or used disposable pipettes and other items, should be put only in waste bins labelled **Sharps** - this is for the safety of cleaning staff who empty waste bins.

Empty glass bottles can be disposed in the special bins provided at the Technical Solvent Store. They should be disposed during solvent collection times. Before they leave your laboratory it is vital that all bottles for disposal are treated in the following way:-

- Any sodium residues in bottles must be carefully destroyed and the bottles washed with water;
- All bottles should be completely emptied of solvents and chemicals then washed and dried to the extent that there is no residual odour from them.

Cryogenic Safety

Refrigerators and freezers

An **explosion-proof fridge** must be used for chemicals. Do not use your refrigerator or freezer as a dump. Make sure everything you put in is tightly sealed in a way that will not leak when cold. Check the contents frequently and discard unwanted samples. **Food must never be stored in a refrigerator used for chemicals.**

Liquid N₂/ Solid CO₂

These substances can freeze-burn you. Equipment cooled outside by liquid N₂ but open to air will allow liquid O₂ to form **inside** which can create a dangerous pressure rise on warming or an explosion with flammable material. Use liquid nitrogen to cool sealed or evacuated systems only.

See <https://chemistry.nus.edu.sg/health-safety/more-safety-information/prepared-risk-assessment-for-chemicals-and-materials/handling-transportation-and-storage-liquid-nitrogen-and-other-cryogenic-material/>

for handling, transportation and storage of liquid nitrogen. Transport of liquid nitrogen in public lifts is especially dangerous. To avoid in possible risks from nitrogen boil off during, for example, a prolonged period of lift breakdown, Dewars of liquid nitrogen **must not** be accompanied in lifts. Rather, two people should be assigned to transport the Dewars, one to load and one to receive at the destination floor. To prevent others from entering the lift, fitted straps should be pulled across the entrance.

Radiation and Laser Safety

Radiation

Only Radiation Workers who have been licensed to be engaged in radiation work are allowed to handle radioactive materials and waste resulting from radioactive materials they have used. Proper control, safe packaging and identification of the waste before the waste must be ensured for safe handling by nonradiation workers. You must keep the internal dose to yourself and others as low as practicable by (a) use of protective clothing; (b) employing good laboratory techniques to minimise

surface and air contamination; (c) not eating, drinking or using of cosmetics etc. in the laboratory. You must monitor: (a) your working area for contamination before and after each working session; (b) your work station for level of activity whilst you are working; (c) yourself by wearing any appropriate Thermo-Luminescent Dose (TLD) badges. You must (a) record all accessions and transfers on the record forms; (b) record waste route destinations every time an isotope is taken from stock; (c) keep all stocks secure; (d) report any incidents (e.g. spills) and follow procedure on room notice.

Laser

The major health risk for persons working with lasers is the potential for eye injury. Eye protection is required when working with lasers in and above Class 3b. Laser radiation should be discharged in a non-reflective and fire-resistant background. The appropriate safety goggles for the laser class must be worn. Laser light should not be in the line of direct vision. No reflective attire should be worn. Pre-employment and post-employment eye examinations are required.

Noise and Safety

Changes in sounds are often a first indication that something is wrong with equipment or machinery. Try to keep background noises from pumps, shakers, compressed air jets, etc. at as low a level as possible for the comfort of everyone and so that you can hear when something is going wrong. **Noisy radios are not permitted in laboratories.**

The use of personal audio equipment which include earphones is forbidden in the research areas and teaching laboratories of the Department of Chemistry.

Out of Hours Working

There are special risks from working in a laboratory in the Department outside normal working hours (8:30 a.m. – 6:00 p.m. Monday to Thursday, 8:30 a.m. – 5:30 p.m. on Friday) as help may not be available in the event of an accident. **It is the duty of all Research Supervisors to be aware of the work being undertaken by their students and to ensure that out of hours work is properly regulated.** The following rules apply out of normal hours:-

- **Undergraduates are forbidden to be in laboratories unless a member of the academic staff of the Department is present with them.**
- **Lone working is forbidden.** Make sure there is always someone within calling distance.
- Experiments that involve any measure of risk must be left to normal working hours. **No work involving Cyanides or HF may be carried out outside normal working hours.**

Unattended Experiments

Experimental work left running unattended poses special risks in terms of fires and floods and must be carefully controlled. The following rules apply:

- Unattended running of experiments may be carried out **only when absolutely necessary.**
- Experiments involving overnight refluxing of solvents **must be within a ducted fume-hood.** All water lines must be fixed securely.
- All experiments left on must have a notice on
 - stating **Experiment in Progress Please Leave On**
 - and indicating **potential hazards in plain English** e.g., "*Flammable solvent*", "*Contains Toxic Material*"
 - and the **name and telephone number** of the person who is responsible for it:- This must be a **realistic telephone number where you can be contacted at all times** because **you** may be called out at any time to deal with **your** experiment.

- If at all possible, this information should also be posted in a prominent position external to the laboratory.
- If an unattended experiment is set up in a fume hood, the **lighting for that fume hood should be turned on.**
- Electrical equipment left on should carry a **Do Not Switch Off** notice in yellow card giving the name of the person leaving the equipment and a contact phone number. For **large permanent equipment** like Electron Microscopes, NMR equipment etc. contact numbers should also be posted external to the laboratory and **Emergency Electrical OFF** switches clearly identified within the laboratory.

Pregnancy

Certain chemicals, radiation and physical tasks pose a greater than normal danger to an expectant woman and to her unborn child. If you become pregnant, you should inform your Supervisor **in writing** - they may then be able to help you to avoid exposure to such agents and to any problematic tasks.

Tidiness

The prospect that you and your co-workers stay safe will be increased if you all keep your **working environment reasonably tidy and free of obstacles.**

Reporting Accidents and Incidents

All accidents and incidents are to be reported to ORMC via the online reporting system within 24 h (https://inetapps.nus.edu.sg/osh/portal/eServices/ehs360_aims.html). ORMC will then disseminate the information to the respective Faculty Safety Officers/Committee.

Please note it is mandatory under the Workplace Safety and Health Act to report any accidents/dangerous incidents.

Do not clean up the site of the incident/accident until the safety personnel has inspected it.

Dangerous incidents are defined as unplanned events in which no one was hurt but which either had the potential to cause injury or did cause damage to apparatus, equipment or the building.

Accidents are defined as events in which someone gets hurt.

Regulations on Purchase of Chemicals

1. All chemicals must be bought with purchase orders raised using LMPRS system.
2. You must pass the Chemistry Safety test before you are allowed to login to the LMPRS-LMMS system. If chemicals fall under Chemical Weapons Convention (CWC), you need to apply online to ORMC for the licence to purchase the chemicals (https://inetapps.nus.edu.sg/osh/portal/chem_safety/chemsafety.html).
3. Strictly no Cash-On-Delivery is allowed for purchase of chemicals and solvents.
4. All chemicals and solvents must be delivered to Lab Supplies, Dept of Chemistry, Block S5, Basement Room 3, Science Drive 4, Singapore 117549.
5. When buying chemicals from chemical companies not in Singapore, you must inform them that **proper declaration** of the chemicals is required. Deliveries made without proper declaration of the contents will be returned to the sender at your cost and a report will be made to customs.
6. All chemicals and solvents must be properly stored in the appropriate safety cabinets.
7. Chemicals purchased using LMPRS will be auto-added to the LMMS inventory. To update the amount of chemical used, the bottle must first be barcoded.
8. All regulated chemicals must be barcoded and the usage recorded in LMMS. For non-regulated chemicals, it is not necessary to record the usage.

9. Keeping a usage record is required for chemicals under the Poisons Act, Arms & Explosive Act and CWC. This can be a softcopy version in LMMS or a hardcopy version in a notebook. The chemical must be barcoded before changes to its amount can be made on LMMS.
10. Lab Supplies sells technical solvents, acids, alkalis and some common lab chemicals. To purchase these, use the LMPRS system. Under Manufacturer, search for NUS Chemistry Lab Supplies. The purchase request must be made before 11:30 am. The solvents can then be collected at 2:30 pm (on solvent disposal days) or 3:00 pm (on other days) at the Technical Solvents store. For flammable technical solvents, the maximum volume that you can purchase each time is 60 L (12 x 5 L). **You MUST return the empty canisters before you can buy new stock.** This is to prevent accidental usage of these empty canisters for wastes as incompatibility of the residual solvents with wastes can lead to hazardous reactions. If you do not return the empty canisters, the maximum volume of technical solvents you can buy will not be updated and you will not be able to purchase more technical-grade solvents. The number of empty canisters to return must be inputted into LMPRS when purchasing chemicals/solvents from Lab Supplies. In LMPRS, put down the number of 5L plastic solvent bottles and aluminum canisters under TG, for all other bottles you will be disposing, put the number under Others. If you forgot to enter the number of empty canisters into LMPRS, please inform the Lab Supplies officer to update the returned canisters for you.

Chemical Waste Disposal

For safety and environmental reasons, regulations make the disposal of chemical waste difficult and costly. It is a matter of sensible economics as well as good practice to generate as little waste as possible and, wherever practicable, substances should be recovered and recycled.

At the end of research projects, it is necessary to dispose of all unwanted products or other chemicals and researchers are required to follow the instruction for laboratory clearance described in the Safety Manual.

Waste Chemicals

The PI of the individual research project is to make arrangements with a chemical waste disposal company for disposal of unwanted chemicals. Companies include Cramoil Singapore Pte Ltd, Eco Special Waste Management, Aroma Chemical Pte Ltd, Veolia ES, Modern Asia Environmental Holdings Pte Ltd, etc.

All substances to be disposed of should, if possible, be identified by chemical name and molecular formula. If this is very difficult because there is a mixed waste, then the character of the mixture must be accurately defined, *e.g. categorizations such as a mixture of organic amines and their salts but with no compound boiling below 100 °C; some are suspect carcinogens* would be helpful and acceptable (provided it is true) but a categorization such as *mixture of organic liquids, smells of nitrobenzene* will not be acceptable and some work will have to be done by the originators of the waste to determine what else is with the nitrobenzene before it can be accepted. **It is very important that if there are known hazards associated with the waste, these should be stated on the label (see below) including, for example, the inclusion of hazardous drying agents.**

All substances to be disposed of must be put into leak-proof containers that are clearly labelled with the **identity or categorization of the contents, any known hazards, and some indication of boiling point range**. Substances identified only by a trade name will also not be accepted - there has to be some indication of the chemical nature.

General: If material is packed into used boxes, ensure that old labels are obliterated and the container is marked "**this way up**". The total weight should not exceed 5 kg and the dimensions should be about one foot cube. Organic or aqueous liquids should be in glass or plastic containers, solids in metal drums or plastic tubs.

Waste Solvents

The Department has a twice-weekly arrangement to dispose of waste solvents (announced by email on day of disposal). Prior to disposal, you are to submit a form listing the type and quantity of waste to be disposed. At present, the waste solvents are categorized into "chlorinated", "non-chlorinated", "acids" and "base" and the contents must be identified. The date of first generation of wastes must be clearly written. **Waste solvent containers are not dumps** and may contain only approved waste organic solvents with limited amounts of solute. Reaction mixtures containing drying agents, oxidants or solutions of oxidants must never be put into the waste solvent containers. Acids and bases must be placed in separate containers and not into containers for organic solvents.

No substances that are category 1 or 2 carcinogens may be put in the waste solvents in any form.

Organic liquids acceptable as Waste Solvents

Non-chlorinated/halogenated

- Mixed solvents - acetone, ethanol, ethyl acetate, ethylene glycol, hexane, isopropyl alcohol, kerosene, 1-methyl-2-pyrrolidinone (NMP), methanol, methyl ethyl ketone, methyl isobutyl ketone, propylene glycol, thinner, toluene, xylene

Chlorinated/halogenated

- C₁: dichloromethane, chloroform, carbon tetrachloride
- C₂: trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1-trichloroethane,
- C₃: 1-chlorobutane plus small amounts of non-chlorinated materials but no water.

Containers: The accepted container for transfer of waste solvent to the Lab Supplies is a screw-capped 5 L polythene bottle. No other containers are acceptable. **The containers must be filled only to the 80% level with approved solvents, sealed with their original caps, not leaking vapour or liquid or contaminated on the outside.** Stores staff are not allowed to accept over-full, leaking or externally contaminated containers.

Storage: Separate containers for Chlorinated/Halogenated and non-Chlorinated/non-Halogenated solvents should ideally be kept in a fume-hood. Large polythene containers of flammable solvents are extremely vulnerable in case of fire and must be kept in a closed cupboard when not being used to receive waste solvent. Secondary containers are required for the waste canisters.

Transport: Waste solvents should be transported only in designated lifts. No one should enter the designated lifts when waste transportation is being carried out. Two persons should do the waste disposal. One person should push in the trolley, pull the sash across the lift to prevent others from getting in and press the button for the ground floor. The second person should wait at the ground level for the waste trolley to arrive.

Collection: Staff are not allowed to accept containers which do not meet the criteria described under "Containers" above.

Special disposal : for disposal of other chemicals such as waste silica gel, acid and alkali wastes, the appropriate labels – silica gel, acid and base – must be affixed on the waste

container. For solids, waste pump oils, please store them separately and arrange via Lab Supplies for disposal by the waste vendor.

Applicable Legislations

There are a number of legislations applicable in our laboratories. Please check the Safety Manual on the web for more details. Below is a brief summary of the Acts.

1. Fire Safety (Petroleum & Flammable Material) Regulations 2005

Flammable liquids

- Secondary containment tray for all flammable liquids should be made of metal and not plastic.
- The capacity of the secondary containment should be 10% of the total volume of the liquids stored in the containment tray, or the volume of the largest container, whichever is greater (re: SS 641 – Code of Practice for Fire Safety for Laboratories using Chemicals).
- The volume of flammable liquid wastes must also be part of the total licensed PFM volume stored in the laboratory.
- Waste container size cannot exceed 20 L.
- Wherever possible, activities involving flammable liquids should be performed in a fume cupboard, to prevent the build up of a flammable mixture in the room.
- Flammable liquid containers for Class I and Class II (flash point between 37.8 °C – 60 °C) cannot exceed 4 L.

All flammable liquids in NUS are classified as Class 1 (flash point < 37.8 °C) and the storage limit is as follows:

Liquid in Laboratory			
Excluding Qty in Cabinet		Including Qty in Cabinet	
Max Qty (L/m ²)	Max Qty (L/m ²)	Max Qty (L/m ²)	Max Qty (L/m ²)
0.8	250	1.6	500

Gases

- Spacing of 6 m apart is required for each group categorized below.
- Only two 4.5 kg LPG cylinders allowed in lab.
- Flammable gases must be in use in the lab.
- Labs cannot be used for storage of flammable gases.

2. Workplace Safety & Health Act

- The principal investigator or lab-in-charge shall conduct a risk assessment in relation to the safety and health risks posed to any person who may be affected by his undertaking in the workplace.
- The principal investigator shall take all reasonably practicable steps to eliminate any foreseeable risk to any person who may be affected by his under taking in the workplace.
- Every principal investigator shall maintain a record of any risk assessment conducted, any measure or safe work procedure implemented, submit the record when required and shall be kept for a period of no less than 3 years.
- Every principal investigator shall review the risk assessment at least once every 3 years, upon the occurrence of any bodily injury to any person as a result of exposure to a hazard or when there is significant change in work practices.
- All workplace accidents/dangerous incidents must be reported to ORMC.
- Mandatory reporting for workplace accident resulting in the death of an employee
- Mandatory reporting for workplace accident resulting in the injury of an employee who is unfit for work for more than 3 days, regardless of whether these were consecutive days of

medical leave; or hospitalized for at least 24 hours. The reporting shall be done not later than 10 days after the 3rd day of the sick leave.

- Mandatory reporting for a subsequent death of an employee as a result of an injury at the workplace
- Mandatory reporting for a workplace accident which involves a self-employed person or member of public and results in his or her death or treatment in hospital for the injury

3. Environmental Protection and Management Act

- All hazardous chemicals must not be bought or used without approval and license applied for through Faculty Safety and Health Officers.
- Required to keep a record of the quantity of the hazardous substances.
- Storage of the hazardous substances in the approved container, in an area where entry is restricted to authorized personnel, with labeling stated in the code of labeling.
- Personnel are to receive adequate instruction and training to understand the nature of all the hazardous chemicals being stored.
- Establish and keep up-to-date adequate emergency response plan to deal with any spillage.

4. Poisons Act

- Regulates substances classified under Poisons (potent medical substances).
- All poisons must be kept under lock and key in a designated poison cupboard.
- Records of toxins and flammable chemicals must be kept. A softcopy record is allowed so use the ES Online system to update the amount remaining after use.

5. Arms and Explosives (Amendment) Act, Chap 13SPF

- | | |
|------------------------|-----------------------|
| • Ammonium Nitrate | Potassium Nitrite |
| • Ammonium Perchlorate | Potassium Perchlorate |
| • Barium Nitrate | Sodium Chlorate |
| • Guanidine Nitrate | Sodium Nitrate |
| • Hydrogen Peroxide | Sodium Nitrite |
| • Potassium Chlorate | Sodium Perchlorate |
| • Potassium Nitrate | Tetranitromethane |
| • Perchloric Acid | |
| • | |

EP chemicals must be kept under CCTV surveillance. Put the chemicals back to the designated place after use. Do not leave them in your lab or anywhere else.

Keep and maintain a register book or softcopy inventory via ES Online system.

6. Environmental Public Health Act

- Regulates disposal of toxic and environmentally hazardous chemicals.
- Only licensed waste collector must be engaged to collect hazardous waste generated.
- All generated toxic & hazardous waste must be treated & properly packed in specified containers with appropriate labeling.

7. Sewerage & Drainage Act

- Regulates the discharge of waste water into public sewers.
- NUS staff and students not to dispose hazardous materials into the sewer.

8. Chemical Weapons Convention

- For CWC chemicals under Schedule 1 or 2, the Principal Investigator (PI) has to seek approval by ORMC prior to the purchase. Online application at https://inetapps.nus.edu.sg/osh/portal/chem_safety/chemsafety.html

- A copy of the MSDS provided by the supplier must be made available in hardcopy in the laboratory at all times.
- The Principal Investigator must inform ORMC of the transfer of ownership of the scheduled chemicals. The Principal Investigator must inform ORMC of the loss of any scheduled chemicals within 24 hours.
- These chemicals must be kept in a storage cabinet or fridge under lock and key. The key shall be kept by the Principal Investigator. Only personnel authorized by the Principal Investigator will be allowed to use the chemical weapon.

9. Biological Agent & Toxins Act

- Regulate the possession, use, import, transfer and transportation of biological agents (BAs) and toxins that are known to be hazardous to human health in Singapore.
- Approval is required for the possession, import, handling and transportation of scheduled biological agents and toxins.
- Proper decontamination is required for all waste prior to disposal.
- Agent-specific license issued by MOH to PIs.

Security in the Department

All doors should be locked when no one is in the lab or office. Also be alert if a stranger pops into your lab. Ask what he/she wants. You should contact security at extension 6874 1616 if you are unsure what the person wants.

All corridor doors should be locked after office-hours. **When you enter/exit a corridor, make sure that you have locked the door after you.**

The roll call form listing the persons authorized to work in your lab should be updated regularly whenever there is a change.

Personnel Connected with Safety in the Department of Chemistry

A/P Chuah Gaik Khuan (Co-Chair)	62839
A/P Ge Shaozhong (Co-Chair)	67761
Mr Johannes Murti Jaya (Deputy Chair, Safety Officer)	61760
Ms Chen Yixin	65165533
Dr Stephen Chui Sin Yin	65163699
Dr Irwan Iskandar bin Roslan	66016716
Ms Leng Zhi Jin	66017404
Ms Livonne Ng Voon Kunn	66017410
Mdm Nur Aqilah Binte Mohamad Yakub	65161545
Mdm April Ong Bee Hoon	66017411
Ms Sanny Tan Lay San	66017413
Asst/Prof Wei Jiangbo	66018844
A/P Suresh Valiyaveetil	65164327
Dr Wong Ling Rong	66016973
Dr Steven Yuan Cheng-Hui	66017421
Asst/Prof Zhu Ye	66017501
Mr Ng Jun Wei (student rep, A/P Koh Ming Joo's lab)	
Mr Toh Ren Wei (student rep, A/P Wu Jie's lab)	
Mr Gao Jiacheng (student rep, A/P Chi Chunyan's lab)	

Internet Address and Further Information

The **Department of Chemistry Safety Manual** can be accessed at:-

<https://chemistry.nus.edu.sg/health-safety/more-safety-information/>

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